A Rainfall Disaggregation Scheme for Generating Fine Time-scale Extreme Rainfall under Climate Change

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Abstract

Extreme rainfall can be calamitous to the ecosystem, life, society, and economy through rapidly developing (flash) floods and is likely to intensify in a warmer future climate. Such intensification is however less well understood for the rainfall in short durations (e.g., hourly; 1h) due to the coarse time-scale of climate models. This study proposes an artificial neural network (ANN) model for disaggregating coarser time-scale (i.e., 3h) rainfall datasets to finer time-scale (i.e., 1h) extreme rainfall (i.e., annual maximum series (AMS)), targeting a data-scarce county like Cambodia by using the 1h rainfall dataset and multiple meteorological covariates datasets (e.g., temperature, wind velocity, and surface latent & sensible heat flux (SLHF&SSLF)) provided by ERA5 reanalysis products. The ANN model was trained by using the information of extreme rainfall events extracted from this 1h rainfall dataset and of the associated simultaneous weather conditions signified by specific combinations of these meteorological covariates. The rationale is that future extreme rainfall patterns will resemble the historical extreme rainfall patterns if similar weather conditions exist during the extreme rainfall events. Covariate importance analysis shows that the most important covariates for the disaggregation are SLHF&SSLF and wind velocity. The proposed ANN model reproduced the observed 1h AMS satisfactorily, with R2 of 0.93 and mean absolute percentage error (MAPE) of 6.1%, averaged for the study area. This ANN model is flexible enough to be extended to other time scales (e.g., daily to sub-hourly) and can be used for similar studies globally. Future work will consider more meteorological covariates, which can be both provided by the ERA5 reanalysis products and climate models, as the predictors.

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Extreme rainfall can be calamitous to the ecosystem, life, society, and economy through rapidly developing (flash) floods and is likely to intensify in a warmer future climate. Such intensification is however less well understood for the rainfall in short durations (e.g., hourly; 1h) due to the coarse time-scale of climate models. This study proposes an artificial neural network (ANN) model for disaggregating coarser time-scale (i.e., 3h) rainfall datasets to finer time-scale (i.e., 1h) extreme rainfall (i.e., annual maximum series (AMS)), targeting a data-scarce county like Cambodia by using the 1h rainfall dataset and multiple meteorological covariates datasets (e.g., temperature, wind velocity, and surface latent & sensible heat flux (SLHF&SSLF)) provided by ERA5 reanalysis products. The ANN model was trained by using the information of extreme rainfall events extracted from this 1h rainfall dataset and of the associated simultaneous weather conditions signified by specific combinations of these meteorological covariates. The rationale is that future extreme rainfall patterns will resemble the historical extreme rainfall patterns if similar weather conditions exist during the extreme rainfall events. Covariate importance analysis shows that the most important covariates for the disaggregation are SLHF&SSLF and wind velocity. The proposed ANN model reproduced the observed 1h AMS satisfactorily, with R^2 of 0.93 and mean absolute percentage error (MAPE) of 6.1%, averaged for the study area. This ANN model is flexible enough to be extended to other time scales (e.g., daily to sub-hourly) and can be used for similar studies globally. Future work will consider more meteorological covariates, which can be both provided by the ERA5 reanalysis products and climate models, as the predictors.